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Greenhouse Gas Emissions from Soil Treated with Dung Pats

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Rationale

Change in grazing density can influences dung distribution patterns, with potential impacts on the abundance and frequency of dung beetles populations and nutrient cycling in grazing systems. The goal of this research was to quantify and characterize the fate of nutrient pulses from cow dung after deposition, and the associated effects of dung beetle activity. Mass and nutrient loss of dung, changes in soil nutrients below and around dung pats, and fluxes of greenhouse gases (GHGs) were monitored overtime. The results on GHG fluxes are presented here and another paper by Evans et al. presents soil results.

Hypotheses

Dung beetles activity can affect the amount and timing of pulses of GHGs emitted from decomposing dung pats.

- Dung pats exposed to dung beetle activity will emit higher fluxes of CO_2 and N_2O, and lower fluxes of CH_4 than those not exposed to dung beetles.
- Dung pats exposed to dung beetle activity will exhibit peak fluxes of CO_2 earlier and peak fluxes of N_2O later than those not exposed to dung beetles.

Materials & Methods

Site Description

Research was conducted at the University of Nebraska-Lincoln, Barta Brothers Ranch (42˚ 13'28.65"N, 99˚ 38'19.17"W) on subirrigated, sandy to fine sandy loam soils in the Valentine series.

Experimental Design and Treatments

- Three treatments were arranged in a repeated measurement RCB with 8 blocks and replicated during grazing season (sequential June and July experiments).
- Treatments included artificially created 20 cm diameter pats from 1.5 L of homogenized beef cattle manure placed directly on the ground (BEETLE), inside a wire-mesh exclusion cage (NO BEETLE), and a no dung treatment (CONTROL).
- Gas samples were taken at 1, 2, 3, 7, 10, 14, 21, 28, and 56 days after dung pat application (DAA).

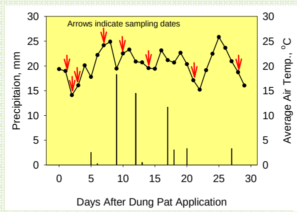
Measurements and Analyses

- GHGs sampling followed GraceNet protocols for chamber method (Parkin and Venturea, 2010), with collection in 10 min. intervals for up to 30 min. on specified DAA.

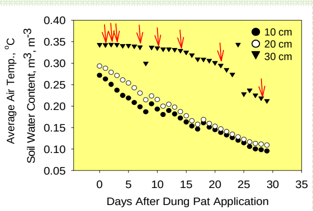
- Samples were analyzed for CO_2-C, N_2O-N, and CH_4-C concentrations using a Varian GC-450.
- Soil temperature and moisture at 10 and 20 cm depths, air temperature, and precipitation were monitored continuously a weather station.
- Fluxes of GHGs were calculated from regression analysis for each DAA (Parker and Venturea, 2010).
- Generalized linear mixed model with repeated measures. Separation of treatments were done using LSM (alpha=0.05).

Results

Weather and Soil Water Content - June experiment (28 DAA)



Cumulative precipitation: 57 mm.
Average air temperature: 20.3 ºC.



Water table was at 50 cm in most of the experimental plot area at 0 DAA. Decrease in water content over time was more pronounced at 10 and 20 cm depth.

Dung Beetle Colonization of dung pats

Treatment	Dung Beetles
NO BEETLE	0.5 ± 0.5 b
BEETLE	8.5 ± 1.5 a

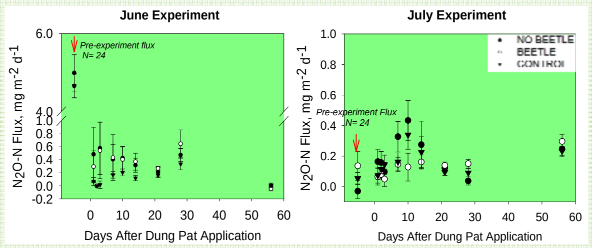
Mean ± se dung beetle number per dung pat. n=8.

Dung beetle abundance was tested using flotation plus manual search on dung pats harvested at 1, 2, and 3 DAA

At 1, 2, and 3 DAA dung beetle counts were significantly less in the NO BEETLE than in the BEETLE treatment..

Placing dung pats inside wire mesh cages effectively excluded dung beetles.

N2O-N Flux



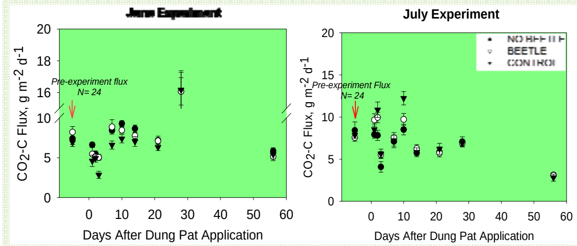
June

- Sampling time was significant.

July

- Treatment by sampling time interaction was significant
  - 10 DAA: NO BEETLE = control; NO BEETLE > BEETLE; BEETLE < control
  - 28 DAA: NO BEETLE = control; NO BEETLE < BEETLE; BEETLE = control
  - 1, 2, 3, 7, 14, 21, and 56 DAA: NO BEETLE = BEETLE = control

CO2-C Flux



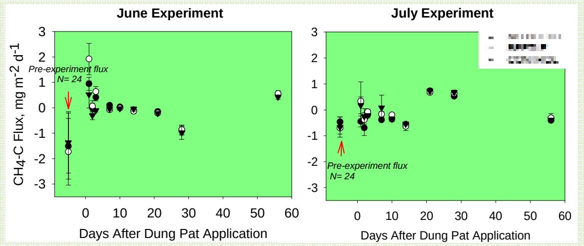
June (wetter)

- Treatment and treatment by sampling time interactions were significant.
  - 1 DAA, NO BEETLE > BEETLE > control
  - 3 DAA: NO BEETLE = BEETLE; NO BEETLE > control; BEETLE > control
  - 7 DAA: NO BEETLE = BEETLE; NO BEETLE = control; BEETLE > control
  - 10 and 14 DAA: NO BEETLE = BEETLE; NO BEETLE > control; BEETLE = control
  - 2, 21, 28, and 56 DAA: NO BEETLE = BEETLE = control

July

- Treatment and interactions were not significant

CH4-C Flux,



June

- Sampling time was significant

July

- No significant effects.

June experiment field layout (left), dung beetles on a BEETLE dung pat (top).

Summary and Conclusions

- Treatment was significant for CO2-C flux but not for N2O-N and CH4-C fluxes
- CO2-C flux was highest in NO BEETLE TRT 5 out of the 9 sampling dates.
- There was no consistent trend in GHG flux when pat was covered to exclude dung beetles and flux was similar between NO BEETLE and BEETLE TRTs.
- Contrary to Pentilla et al., 2013 and initial hypothesis, June CO2-C flux was most often highest from NO BEETLE treatment and there was no significant difference in treatments during July.
- In accordance with Pentilla et al., 2013 and initial hypothesis, July peak N2O-N flux occurred at later DAA in BEETLE compared to control and NO BEETLE.

Acknowledgement

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